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(71) Applicant: EASTMAN KODAK COMPANY  
Rochester, New York 14650 (US)

(72) Inventor: Modney, David L.  
Rochester, New York 14650-2201 (US)

(74) Representative:  
Lewandowsky, Klaus, Dipl.-Ing. et al  
Kodak Aktiengesellschaft,  
Patentabteilung  
70323 Stuttgart (DE)

### (54) Home health care system

(57) A home health care system comprising: patient station including a first videophone, an electronic imaging assembly and a stethoscope assembly, coupled to said first videophone, for respectively producing digital image and physiological sound signals of a patient, wherein said first videophone simultaneously transmits said digital signals over a public telecommunications network; and a health care provider's station including a

second videophone, a video display and a sound reproducer, wherein the second videophone receives digital signals from the first videophone over the public telecommunications network, displays the images of the patient on the display, and reproduces the physiological sounds of the patient by the sound reproducer.

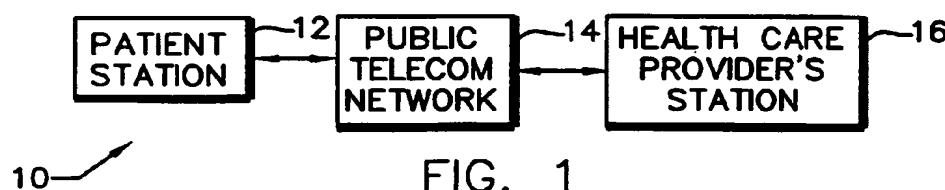


FIG. 1

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**Description****FIELD OF THE INVENTION**

[0001] This invention relates in general to home health care systems and relates more particularly to a home health care system in which video images and physiological data of a patient are digitally transmitted from a patient's video phone to a remote video phone of a health care provider over a public telecommunication network (telephone system). 5

**BACKGROUND OF THE INVENTION**

[0002] There exists a need for a home health care system in which both images and physiological data of a patient at home can be examined by a health care provider (doctor, nurse) at a remote location. The relentless pressure to reduce costs in the health care industry requires more efficient use of a health care professional's services. Although office visits are typical, many patients are either too ill, disabled, or too remote from a health care professional's office to be able to avail oneself of an office visit. As a result, home health care systems have been proposed that allow transmission of physiological data of a patient at home to a health care professional at a remote locate over a public telecommunication network, such as the public telephone system. The following patents and publication disclose various home health care systems using the common telephone to transmit physiological data of a patient, such as body sounds produced by a stethoscope, electrocardiogram (EKG) signals, blood pressure, artificial heart valve clicks, etc. 10

U.S. Patent 5,550,902, issued August 27, 1996, inventor Abbruscato.

U.S. Patent 5,339,821, issued August 23, 1994, inventor Fujimoto.

U.S. Patent 4,883,064, issued November 28, 1989, inventors Olson et al.

U.S. Patent 4,097,691, issued June 27, 1978, inventors Ehrlich et al.

U.S. Patent 3,742,938, issued July 3, 1973, inventor Stern.

U.S. Patent 4,622,979, issued November 18, 1986, inventors Katchis et al.

U.S. Patent 4,428,381, issued January 31, 1984, inventor Hepp.

U.S. Patent 3,810,102, issued May 7, 1974, inventors Parks III, et al.

U.S. Patent 5,666,404, issued September 9, 1997, inventors Ciccotelli et al.

U.S. Patent 5,474,090, issued December 12, 1995, inventors Begun et al.

U.S. Patent 5,321,618, issued June 14, 1994, inventor Gessman.

U.S. Patent 5,357,427, issued October 18, 1994,

inventor Langen et al.

U.S. Patent 5,467,773, issued November 21, 1995, inventors Bergelson et al.

U.S. Patent 5,522,396, issued June 4, 1996, inventors Langer et al.

U.S. Patent 5,704,364, issued January 6, 1998, inventors Saltzstein et al.

U.S. Patent 4,337,377, issued June 29, 1982, inventors Van Riper et al.

J.L. Crouch et al, *Electrocardiograms By Telephone*, Bell Laboratories Record, February 1966.

[0003] These systems are disadvantageous for one or more of the following reasons.

1. The physiological data is transmitted as analog signals which are susceptible to noise and signal degradation resulting in corruption of the transmitted data.

2. Visual images of the patient are not transmitted.

3. The system is expensive, inconvenient, and/or inefficient.

**SUMMARY OF THE INVENTION**

[0004] According to the present invention, there is provided a solution to these problems.

[0005] According to a feature of the present invention, there is provided a home health care system comprising: patient station including a first videophone, an electronic imaging assembly and a stethoscope assembly, coupled to said first videophone, for respectively producing digital image and physiological sound signals of a patient, wherein said first videophone simultaneously transmits said digital signals over a public telecommunications network; and a health care provider's station including a second videophone, a video display and a sound reproducer, wherein the second videophone receives digital signals from the first videophone over the public telecommunications network, displays the images of the patient on the display, and reproduces the physiological sounds of the patient by the sound reproducer.

**ADVANTAGEOUS EFFECT OF THE INVENTION**

[0006] The invention has the following advantages.

1. Physiological data of a patient are transmitted digitally over a public telecommunication network, minimizing degradation and corruption of the data. The health care provider can thus provide a more reliable diagnosis of the patient.

2. Visual images of the patient are digitally transmitted simultaneously with the physiological data, thus enhancing communication between patient and health care provider, and optimizing proper diagno-

sis.

3. The home health care system is cost effective, uses public telecommunication networks, such as the public telephone network, and is convenient to both patient and health care provider.

4. The patient's physiological sounds are stored at the patient station at full resolution, but are initially transmitted to the health care provider's station in a compressed format. Because the data compressor is selectively controllable to compress data at different compression ratios, the health care provider can command the patient station to retransmit the physiological data at a lower compression ratio, thus producing higher quality sound.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### [0007]

Fig. 1 is a block diagram of a home health care system according to the present invention.

Fig. 2 is a block diagram of a patient's station of the system of Fig. 1.

Fig. 3 is a block diagram of a preferred stethoscope sound processing circuit.

Fig. 4 is a block diagram of a health care provider's station of the system of Fig. 1.

#### DETAILED DESCRIPTION OF THE INVENTION

[0008] Referring now to the figures, there is shown a preferred embodiment of the present invention. Fig. 1 is a block diagram of the main components of a home health care system of the invention. As shown, home health care system 10 includes a patient station 12, a health care provider's station 16, and a public telecommunication network 14 connecting stations 12 and 16. Network 14 can, for example, be the public telephone network, cellular phone network, ISDN, Ethernet, Intranet, Internet, or any other network capable of transmitting digital signals between stations 12 and 16.

[0009] In general, each of stations 12 and 16, is provided with a videophone which is connected to network 14. The patient station is located at a patient's venue, such as, the patient's home. The health care provider's station is located at the provider's venue, such as a doctor's or nurse's office, a hospital, or the like. As will be described in more detail later, the patient's station includes a stethoscope which is used by the patient to produce physiological sounds of the patient. The physiological sounds relate to the cardiovascular and respiratory systems of the patient. The sounds are digitized and transmitted by station 12 over network 14 to station 16, where they are reproduced and examined by the health care provider. Images of the patient are simultaneously transmitted over network 14 to enhance the examination and diagnosis of the patient.

[0010] Referring now to Fig. 2, there will be described

a preferred embodiment of patient station 12. As shown, station 12 includes a first videophone 18, a processor 20, and a stethoscope 22. Videophone 18 is a standard videophone (e.g., an 8 × 8 VC50/55) which sends and receives audio and video as digital data over a standard public telephone network 14, or the like. Coupled to videophone 18 are camera 24 for capturing images of a patient, a standard telephone 26, and a video display 28 for displaying images, graphics and data. Processor 20 includes a stethoscope processing circuit 30 for converting patient physiological sounds picked up by stethoscope 22 into compressed digital data transmitted by videophone 18 over network 14 to station 16.

[0011] As shown in greater detail in Fig. 3, stethoscope processing circuit 30 includes a transducer 32 for converting the physiological sounds into analog signals, a volume and filter section 34, an analog to digital converter 36 for converting the analog signals to digital data, and a recirculating buffer memory 38 controlled by direct memory access controller (DMA) 40. Buffer memory 38 stores many seconds of the raw high quality digital physiological sounds data. The digital data is compressed by a tunable loss audio compressor 42. If the health care provider at station 16 wishes to listen to high quality audio at a later time, the recirculating buffer memory 38 can be accessed to recompress the digital data at a different loss level (compression ratio) to produce higher quality audio. The new data is retransmitted. The compressed digital data is stored in a first-in-first-out (FIFO) memory 44. The data from memory 44 is sent to a data channel of videophone 18. The data is then transmitted over network 14 to station 16 along with digital images of the patient.

[0012] Referring again to Fig. 2, processor 20 also includes an input/output (I/O) 46, bus 48, memory 50, hard drive 52 for storing an operating system, programs, and data, CPU 54, keyboard 56, and mouse 58. Processor 20 can be powered by an internal battery or an external power source 60. Other devices can be connected to processor 20 for transmission of other patient physiological data. These devices include blood pressure device 62, patient thermometer 64, weight scale 66, SpO<sub>2</sub> finger sensor 68, peak flow meter 70, and room temperature device 72. The values produced by these devices are digitized by processor 20 and sent by videophone 18 over network 14 in a videophone data channel. Station 12 also includes audio output (speaker) 74 and local stethoscope output 76 (headphones).

[0013] Referring now to Fig. 4, there is shown in greater detail station 16. As shown, station 16 includes a second videophone 80 connected to network 14. Videophone 80 is connected to a standard telephone 81 and to a laptop type computer 82 by audio, video, and data/control links. Computer 82 includes display 84, modem 86, optional network interface 88, optional RS-232 interface 90, computer memory 92, IRDA interface 94, floppy disk drive 96, hard disk drive 98 (storing an

OS such as WINDOWS 95/98), laptop mouse 100, laptop keyboard 102, parallel port 104, battery 106, date/time clock 108, steth processor 110, retransmit higher resolution command control 112. Connected to computer 82 is a camera 114 (which can also be connected to video phone 80), sound reproducer (speaker, headphones) 116, external I/O devices 118 (external mouse, external keyboard, external RS-232 link, external printer), and external power 120. Units 80 and 82 can be housed in the same case or be housed in separate but connected cases.

[0014] The digital image(s) and digital stethoscope data are received in the data channel of second videophone 80. The digital stethoscope data is sent to steth processor 110 of computer 82 (e.g., video phone data channel is sent to a IIC serial output port, the IIC serial data is converted to a RS-232 serial stream of data, the RS-232 serial stream of data is sent to a RS-232 port of computer 82, and stored in memory 92, the memory is read into steth processor 110. Steth processor 110 converts the digital stethoscope sound data to analog data by a digital-to-analog converter. The analog signal is amplified, sent to a power amplifier and then to sound reproducer 116 for the health care provider to hear the stethoscope sounds. The digital images are converted and displayed on display 84.

[0015] If a user desires a higher quality audio sound, the user will actuate control 112 to send a command to the data channel of second videophone 80. The first videophone 18 will receive the command over the data channel from videophone 80, adjust the loss ratio of compressor 42 (Fig. 3), recompress the stethoscope sound data in buffer memory 38 to a higher quality sound data and retransmit the stethoscope sound data from videophone 18 to videophone 80 over network 14. The user at station 16 hears the higher quality stethoscope sounds by sound reproducer 116.

[0016] The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

#### PARTS LIST

#### [0017]

10	home health care system
12	patient station
14	public telecommunication network
16	health care provider's station
18	first videophone
20	processor
22	stethoscope
24	camera
26	standard telephone
28	video display
30	stethoscope processing circuit

32	transducer
34	volume and filter section
36	analog to digital converter
38	recirculating buffer memory
5 40	direct memory access controller (DMA)
42	tunable loss audio compressor
44	first-in-first-out (FIFO) memory
46	input/output (I/O)
48	bus
10 50	memory
52	hard drive
54	CPU
56	keyboard
58	mouse
15 60	external power source
62	blood pressure device
64	patient thermometer
66	weight scale
68	finger sensor
20 70	peak flow meter
72	room temperature device
74	audio output (speaker)
76	local stethoscope output
80	second videophone
25 81	standard telephone
82	laptop type computer
84	display
86	modem
88	optional network interface
30 90	optional RS-232 interface 90
92	computer memory
94	IRDA interface
96	floppy disk drive
98	hard disk drive
35 100	laptop mouse
102	laptop keyboard
104	parallel port
106	battery
108	date/time clock
40 110	steth processor
112	retransmit higher resolution command control
114	camera
116	sound reproducer
118	external I/O devices
45 120	external power

#### Claims

##### 1. A home health care system comprising:

a patient station including a first videophone, an electronic imaging assembly and a stethoscope assembly, coupled to said first videophone, for respectively producing digital image and physiological sound signals of a patient, wherein said first videophone simultaneously transmits said digital signals over a public telecommunications network; and

a health care provider's station including a second videophone, a video display and a sound reproducer, wherein said second videophone receives said digital signals from said first videophone over said public telecommunications network, displays said images of said patient on said display, and reproduces said physiological sounds of said patient by said sound reproducer.

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2. The system of claim 1 wherein said stethoscope assembly includes a transducer for transducing physiological sounds of a patient into analog signals, a converter for converting said analog signals into digital physiological sound data, a recirculating buffer memory for storing said digital physiological sound data, a digital data compressor for compressing said digital physiological sound data by a compression ratio that is selectable over a range of compression ratios, and a memory for storing said compressed physiological sound data, wherein said first videophone transmits said compressed data over said network to said second videophone.
3. The system of claim 2 wherein said health care provider's station includes a control for commanding said compressor at said patient's station to compress said digital physiological sound signals at a lower compression ratio to produce higher quality sound, and to retransmit said newly compressed signals over said network for reproduction at said health care provider's station.

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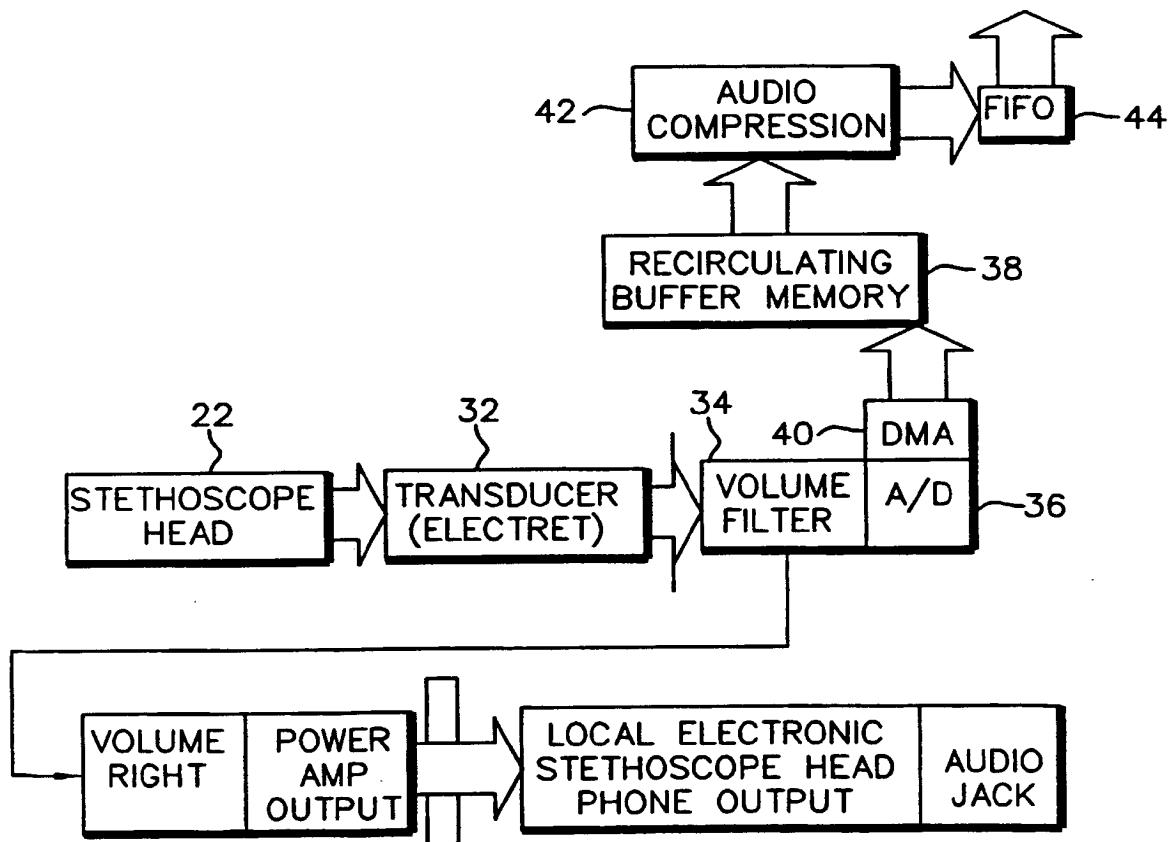
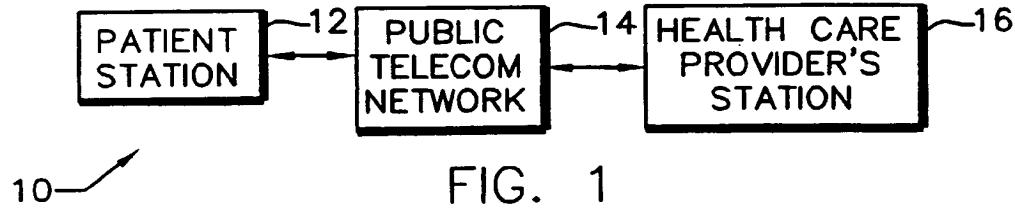
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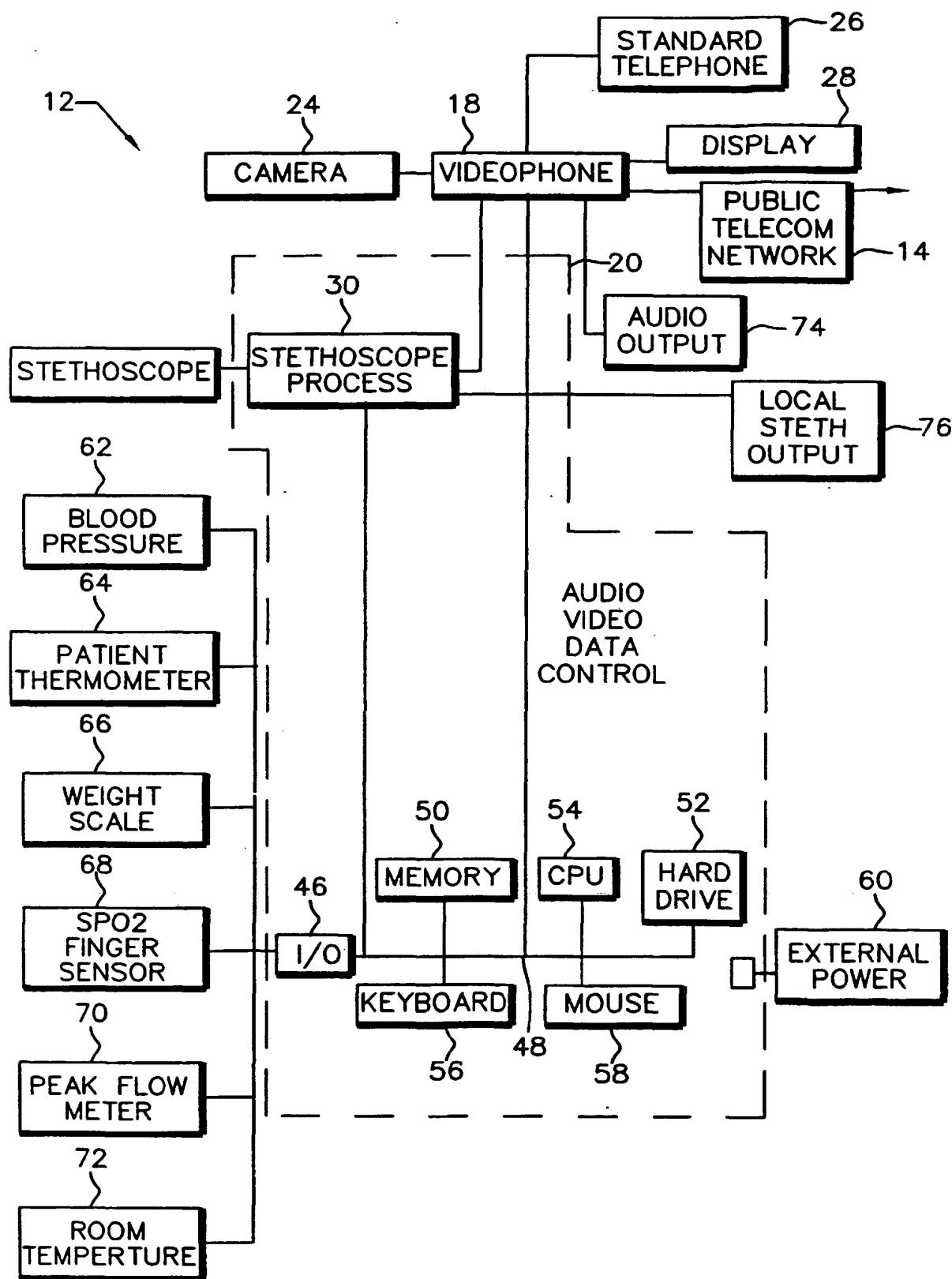


FIG. 2

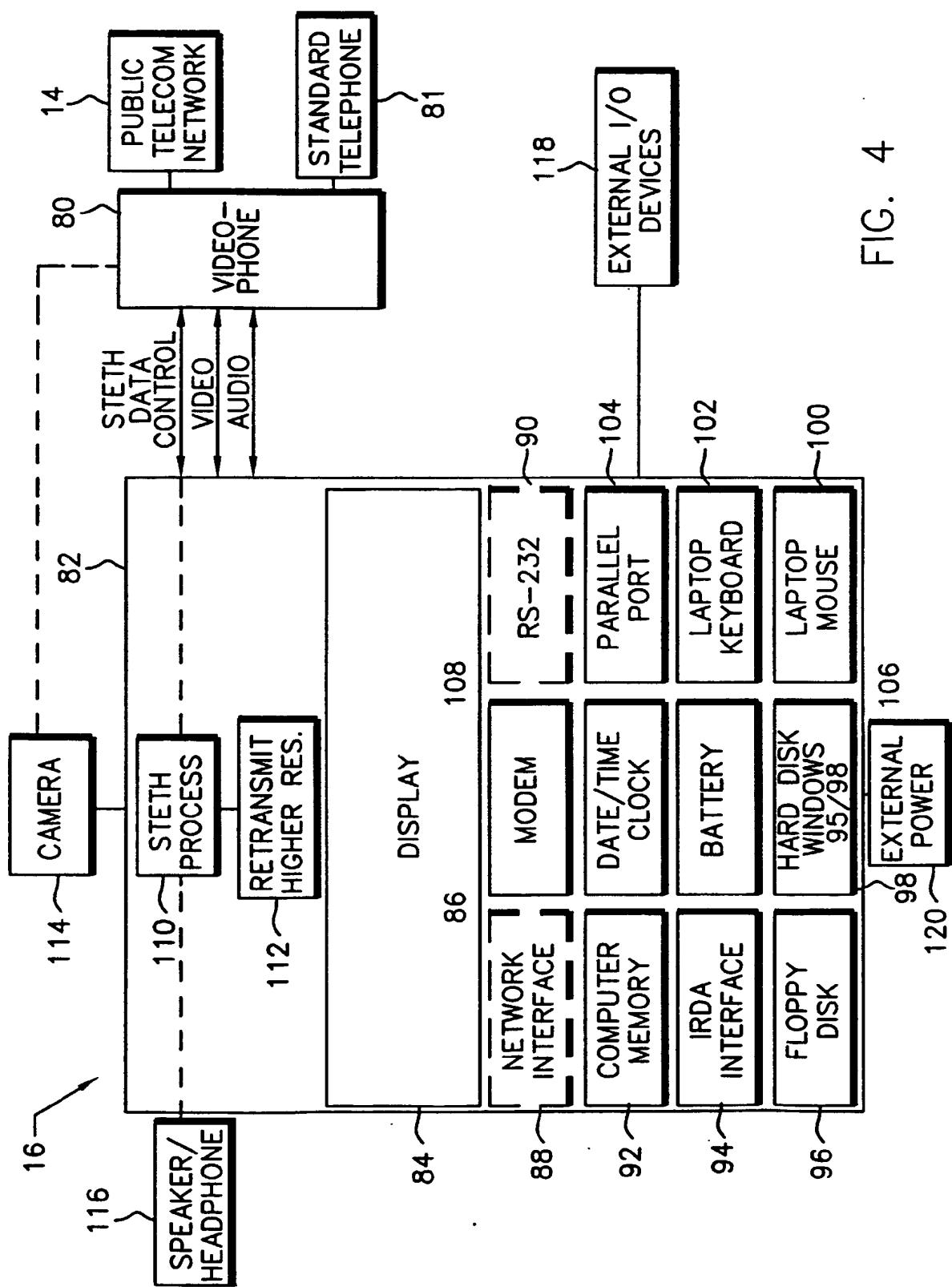


FIG. 4

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Rochester, New York 14650 (US)

(72) Inventor: **Modney, David L.**  
Rochester, New York 14650-2201 (US)

(74) Representative: **Weber, Etienne Nicolas et al**  
**Kodak Industrie,**  
**Département Brevets,**  
**CRT,**  
**Zone Industrielle**  
**71102 Chalon sur Saône Cedex (FR)**

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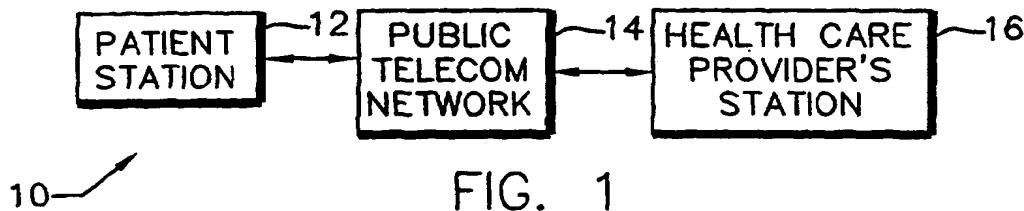


FIG. 1



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## EUROPEAN SEARCH REPORT

Application Number  
EP 99 20 1478

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.6)		
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim			
X	US 5 704 364 A (COFFMAN DAMON J ET AL) 6 January 1998 (1998-01-06) * abstract * * column 1, line 58 - column 2, line 4 * * column 5, line 57 - line 61 *	1	H04M11/06 A61B5/00 H04N7/00 H04M11/04		
A	---	2,3			
A	US 5 544 649 A (DAVID DANIEL ET AL) 13 August 1996 (1996-08-13) * abstract *	1			
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			TECHNICAL FIELDS SEARCHED (Int.Cl.6)		
			H04M A61B		
The present search report has been drawn up for all claims					
Place of search	Date of completion of the search	Examiner			
THE HAGUE	13 October 2003	Mikkelsen, C			
CATEGORY OF CITED DOCUMENTS					
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document					
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document					

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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